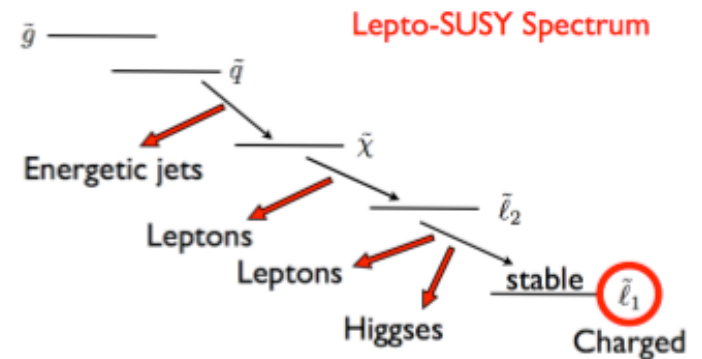


Test studies on LeptoSusy sample

Simona Rolli

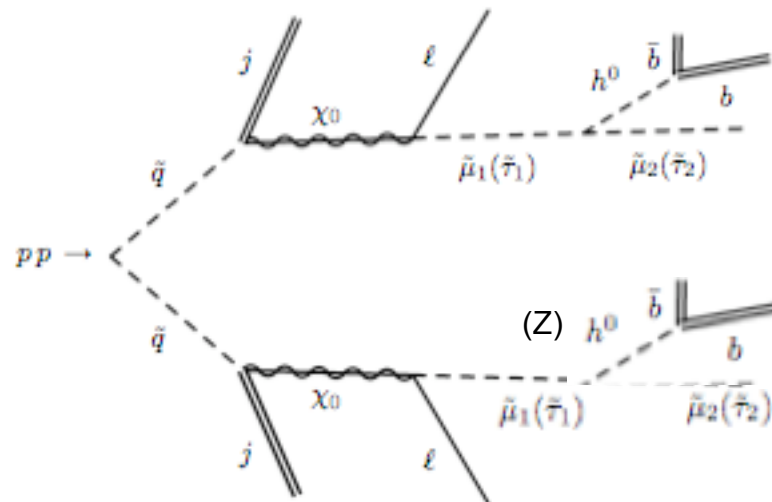
The model

- Leptogenic Supersymmetry
 - SUSY scenario characterized by cascade decays with copious lepton production;
 - Striking signatures that can be probed with just 200 pb^{-1} at LHC 10TeV
 - Long-lived sleptons
 - Several Isolated leptons
 - Energetic jets
 - No MET
 - Copious Higgs production...



Higgs production and decay

- The SM-Higgs boson in this scenario is light enough to not decay into WW;
- It decays predominantly into $b\bar{b}$ ($\text{Br} = 80\%$)
- Higgs is produced in cascade decays and it's free of most of the SM background
 - Clean $b\bar{b}$ invariant mass distribution study



Sample

- Using a special file from Veronica, we generated events in the Athena environment and studied them at generator level and at jet level using the JetTruthCollection
- These studies were considered necessary before submitting a request for a large sample through the central production service
- Athena> csc_evgen08new_trf.py 000001 1 5000 1234
MC8.000001.MadGraphPythia.py test.root NONE NONE
MadGraph.000001.test._00001.events.tar.gz NONE
- We analyzed two samples:
 - One with only Higgs production;
 - One with all processes

Events

- All the events contain a combination of the following particles in the final state:
 - eR (code 2000011)
 - mu2 (code 2000013)
 - ta1 (code 1000015)
 - Electrons (11) muons (13) and taus (15)
 - All events contain at least one bbar pair;
 - All events contain 1 or 2 Higgses (1 or 0 Z's)

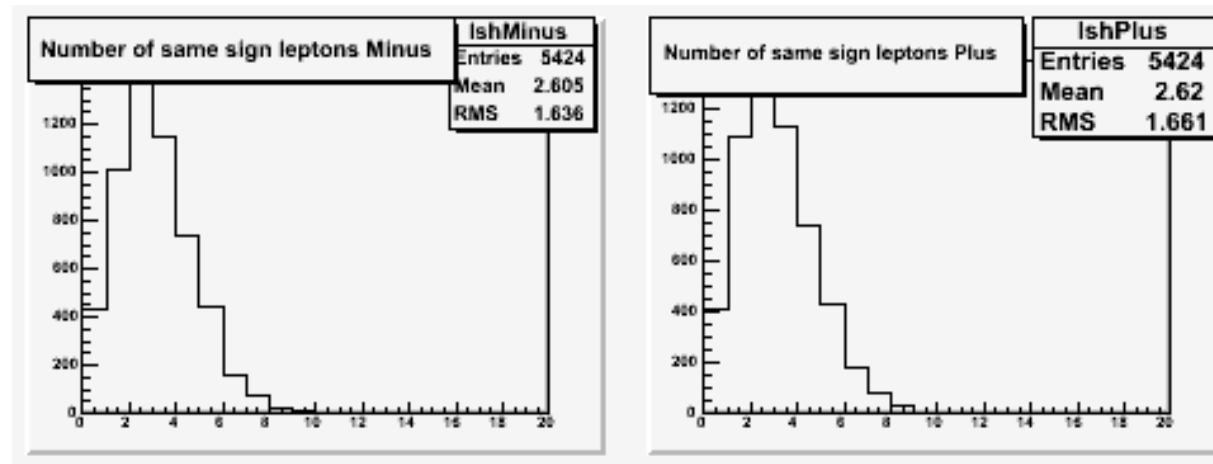
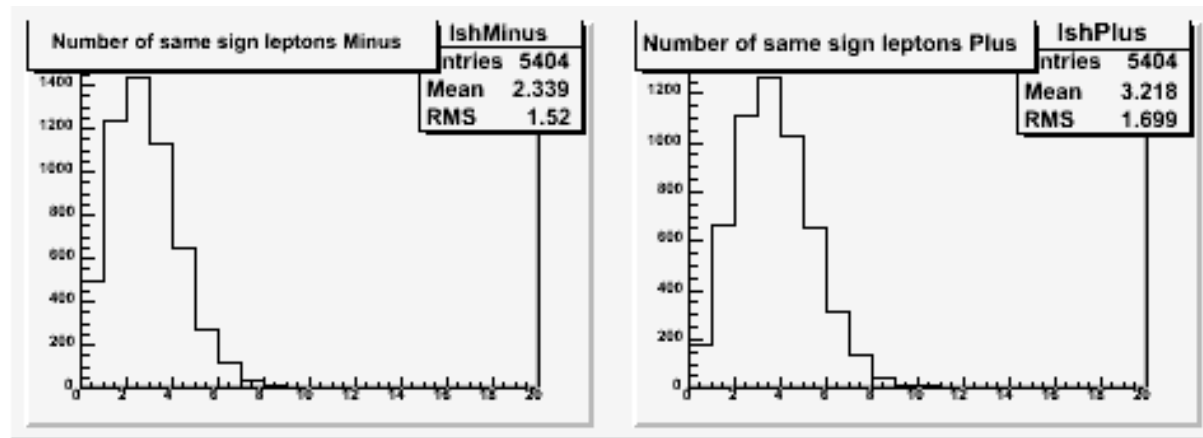
$$\text{BR}(\tilde{\mu}_1 \rightarrow h^0(Z) + \tilde{\mu}_2) = 44.1\% (35.1\%)$$

$$\text{BR}(\tilde{\tau}_1 \rightarrow h^0(Z) + \tilde{\tau}_2) = 53.3\% (46.6\%)$$

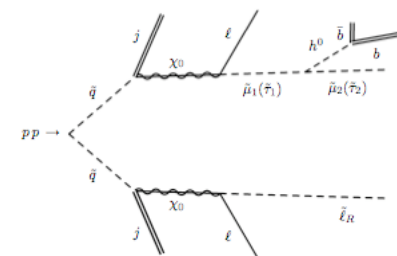
Studies

- Check sleptons multiplicity: we expect 2
- Check on Higgs mass reconstructed from the b-partons
 - Select b's and check for their mother
 - Select Higgs and checking its children
 - Same result in both procedures
- Reconstructed mass of third and fourth jet (as from the theory paper)
 - Mass way higher
 - High jet multiplicity (too high)
 - Run with cone 0.7
 - Done but multiplicity still high
 - Select jets matched to b's in DeltaR and plots their reco mass
 - Done....but structure observed.
 - TruthJet multiplicity and removing the “slepton-jets”

Lepton multiplicities

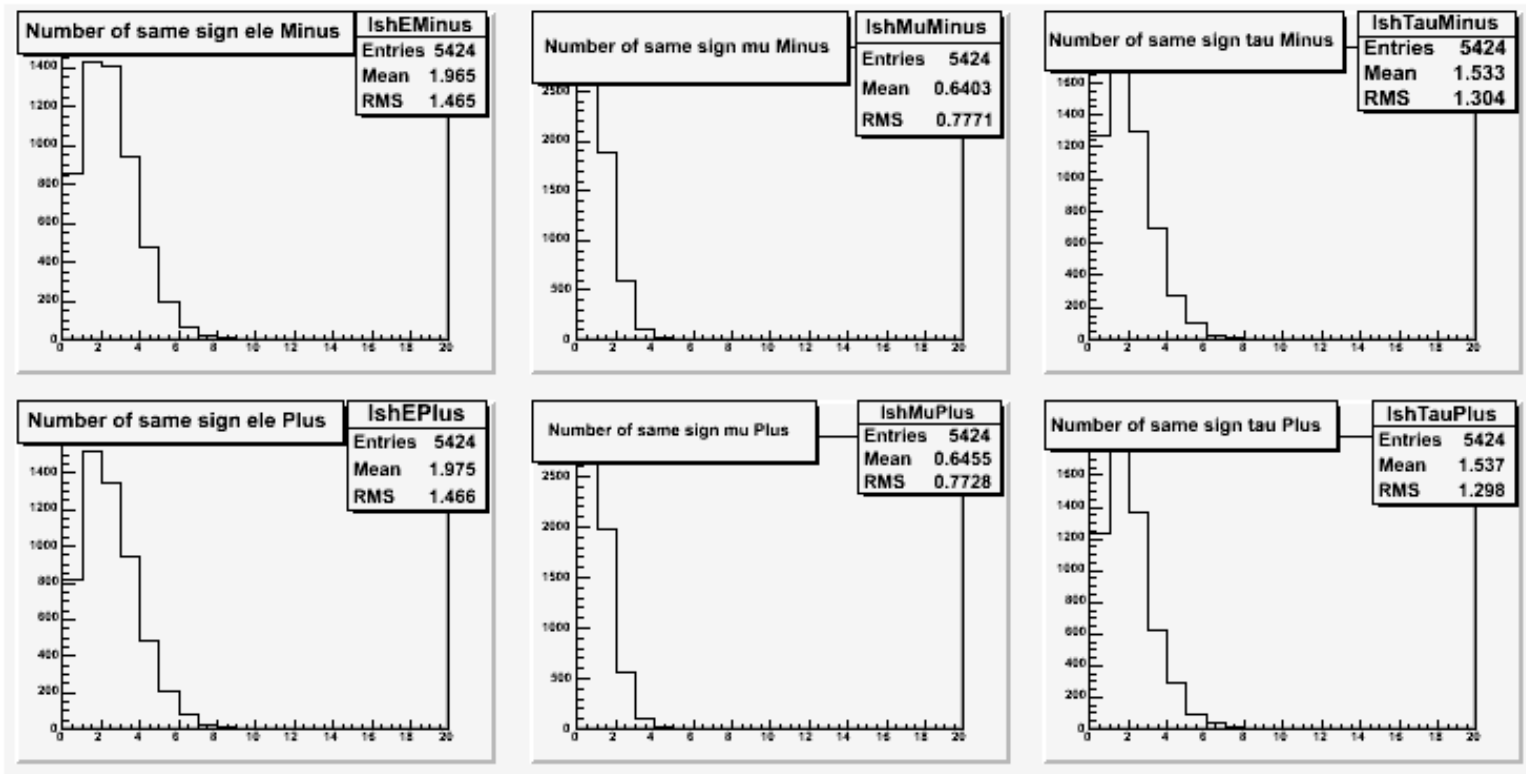


Higgs-only



Number of same sign leptons (flavor blind)

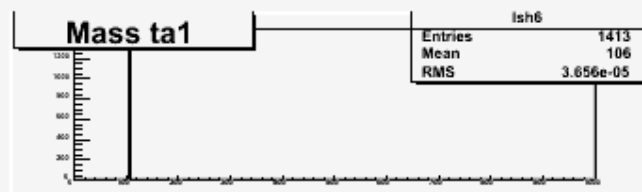
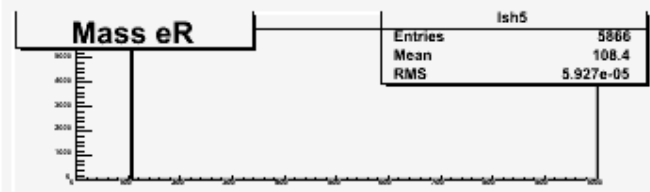
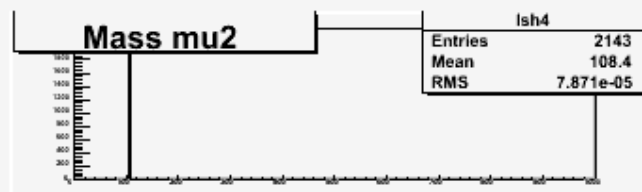
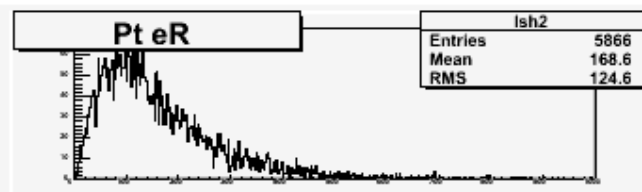
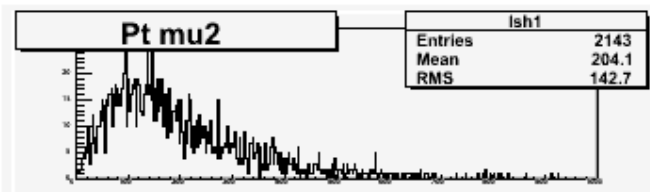
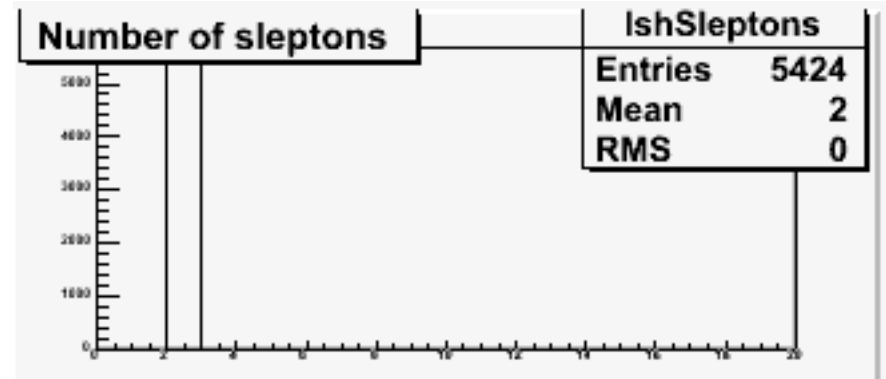
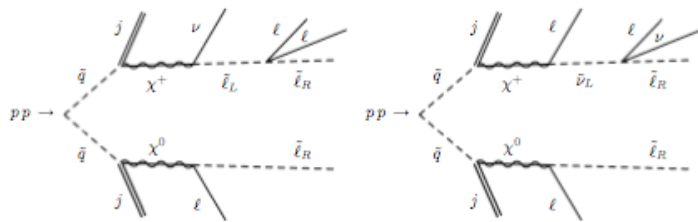
Same Sign Leptons



Higgs Only

Sleptons multiplicity

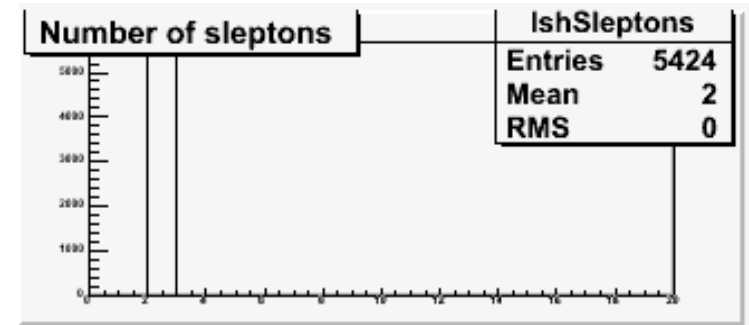
There should be two for each event



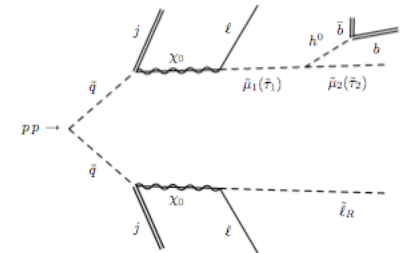
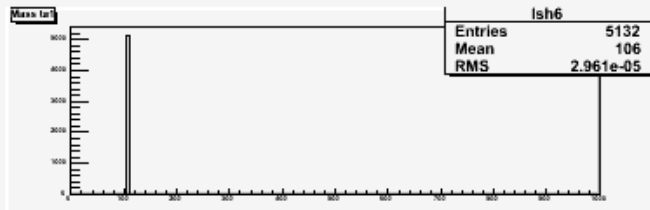
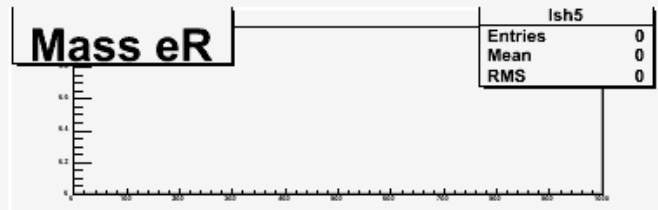
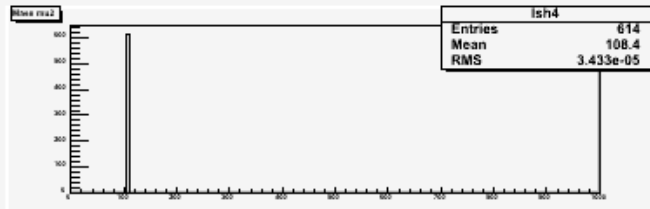
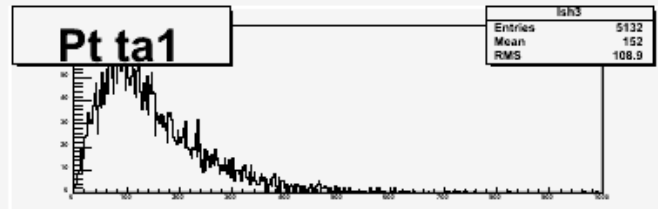
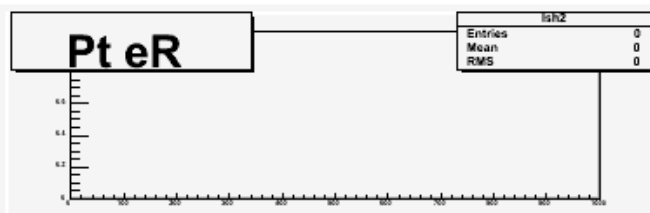
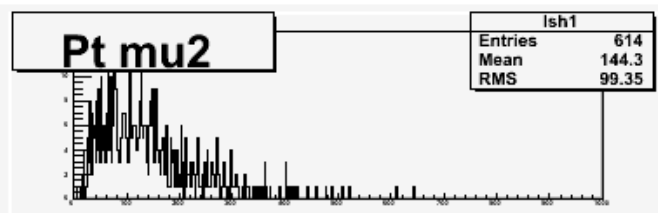
All Processes
(eR is not present in
events with Higgs
production)

Sleptons Multiplicity

there are no eR



Higgs-only sample

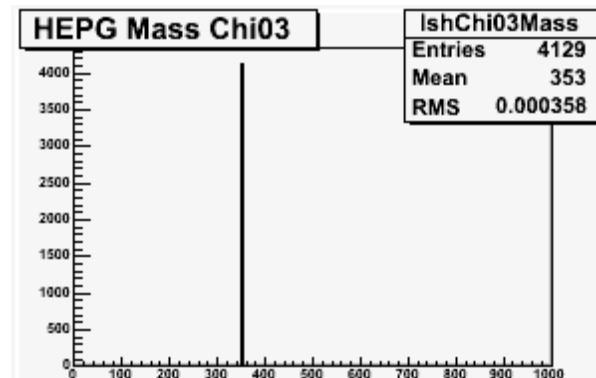
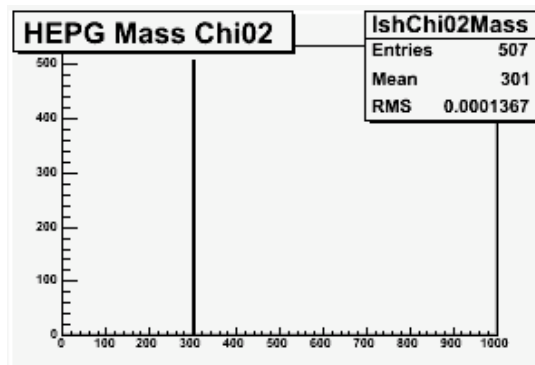
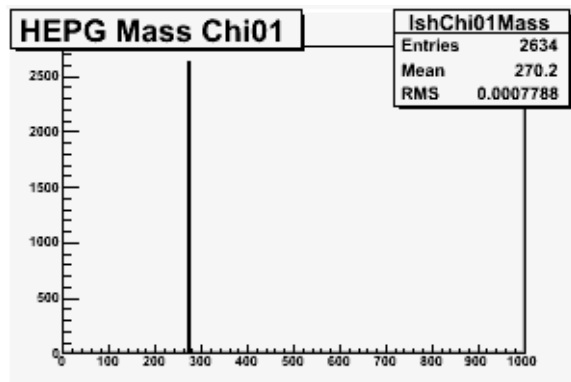


Mass Combinations

There are generally the following neutralinos with status code 3 or 2

I used the ones with code 3 (hard process particle) to plot their mass at generator level:

chi0_1(270),chi0_2(301),chi0_3(353)



Mass Combinations

Selection:

- Loop on nhep, look for particle with code 2000011 (eR/-eR)

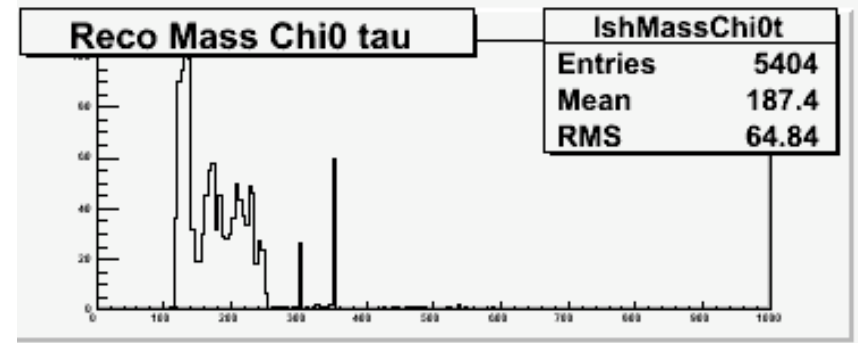
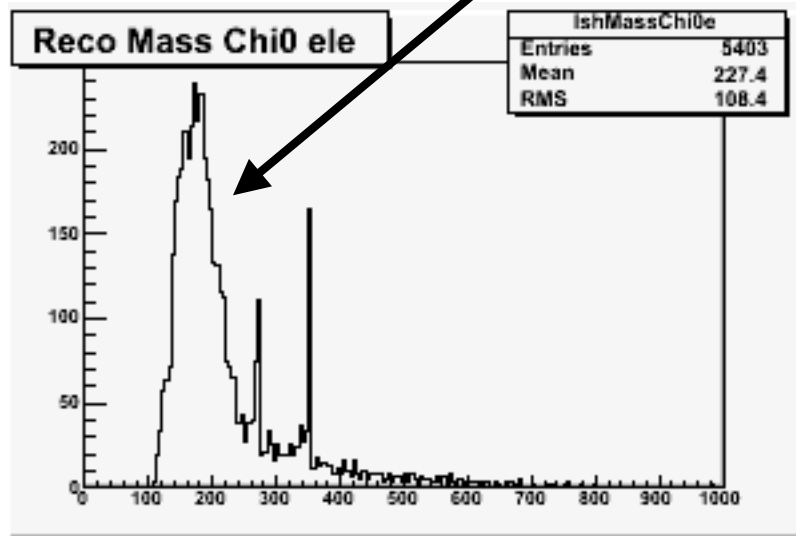
If found, loop on nhep and look for electron (opposite sign to eR)

Since there seem to be several electrons in an event, select the first on the list

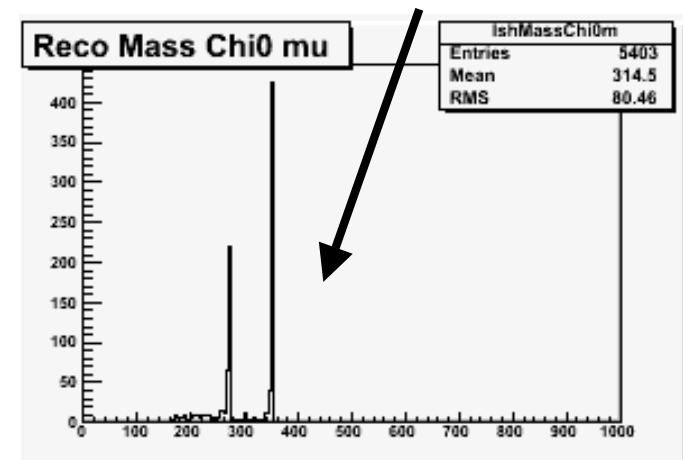
Plot invariant mass (eR-e)

- Same for mu2-mu and ta1-tau

Here there is a large contribution at low mass
(due to the kinematics of the 3-body decay)



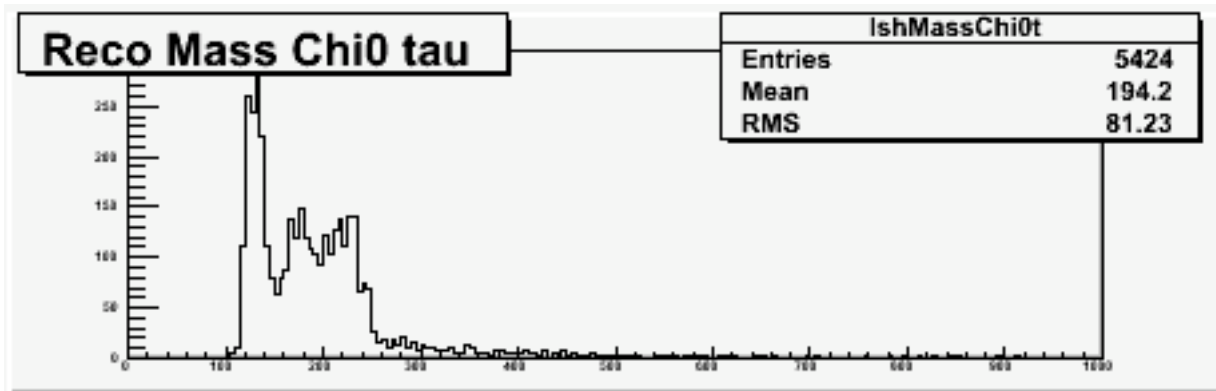
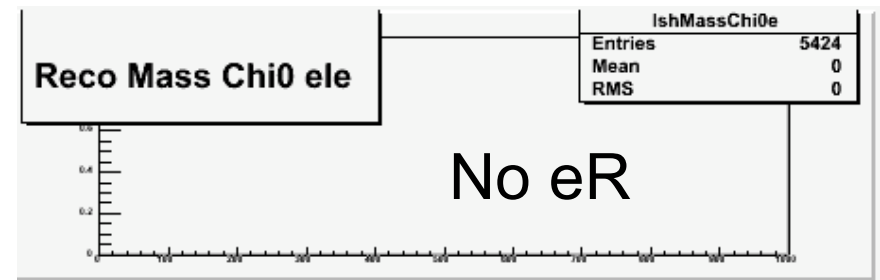
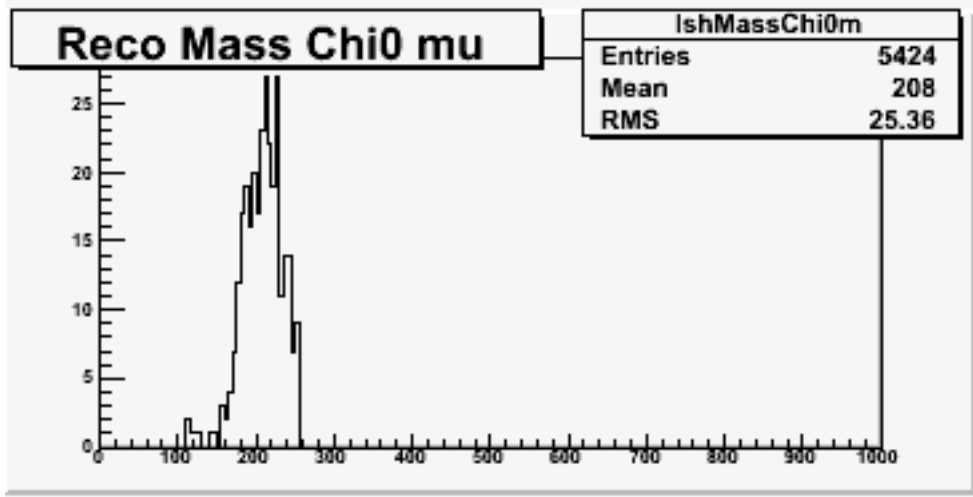
Here we can recognize
the chi02 and the chi03



All Processes

Mass Combinations

Higgs Only sample

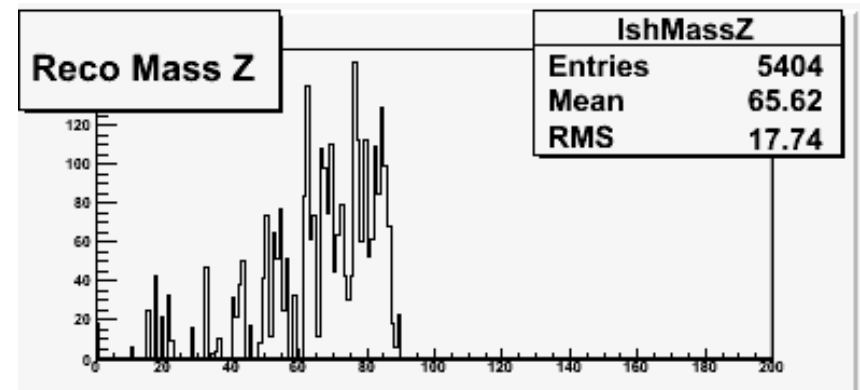
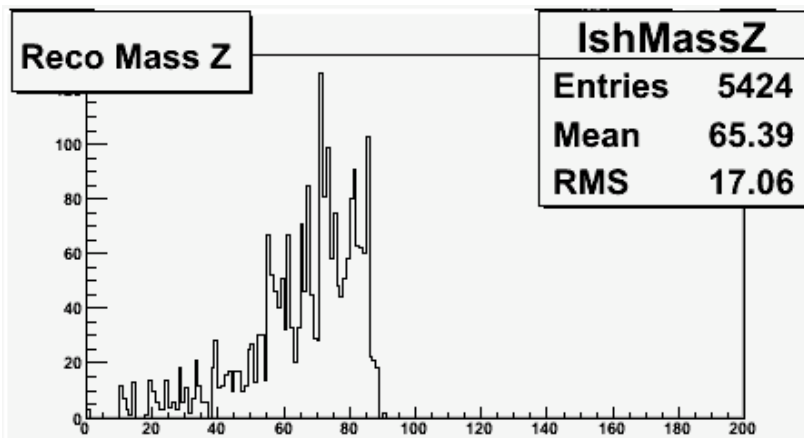
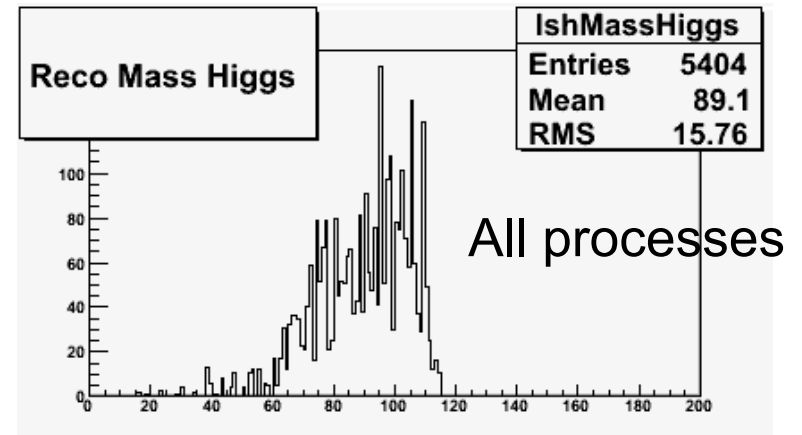
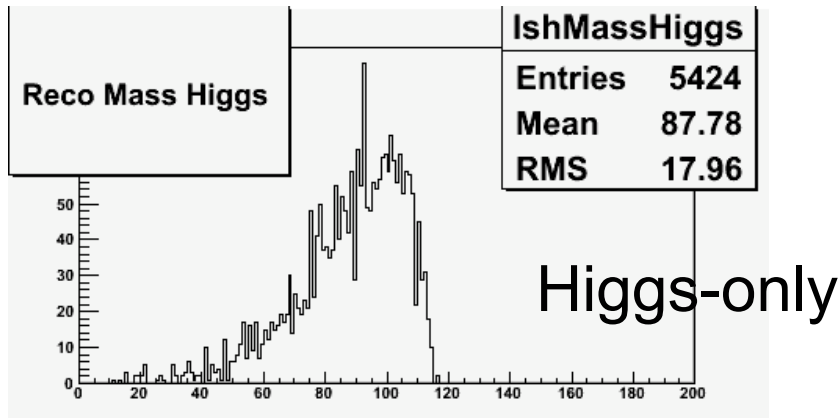


bbar mass

Select a pair of b-bbar with istat code 2

Check their mother ID to be 25 (Higgs) or 23 (Z)

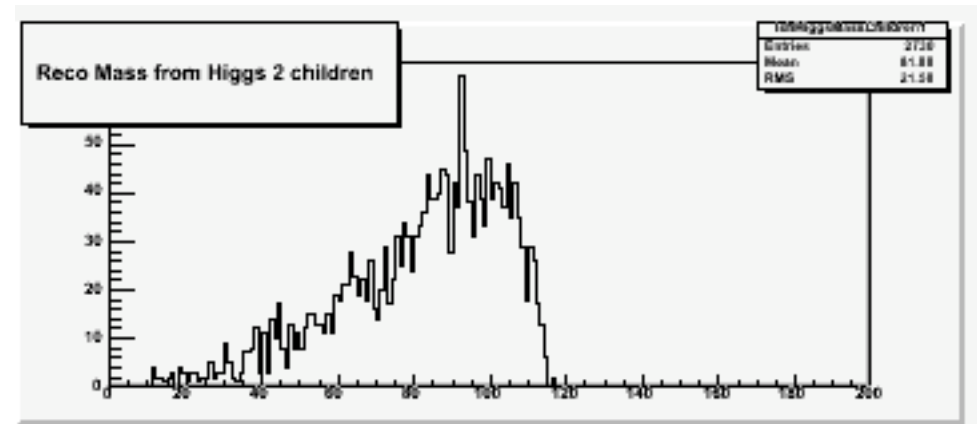
Plot the invariant mass of the bbbar system for events with 2 sleptons and $PT(b) > 25$ GeV



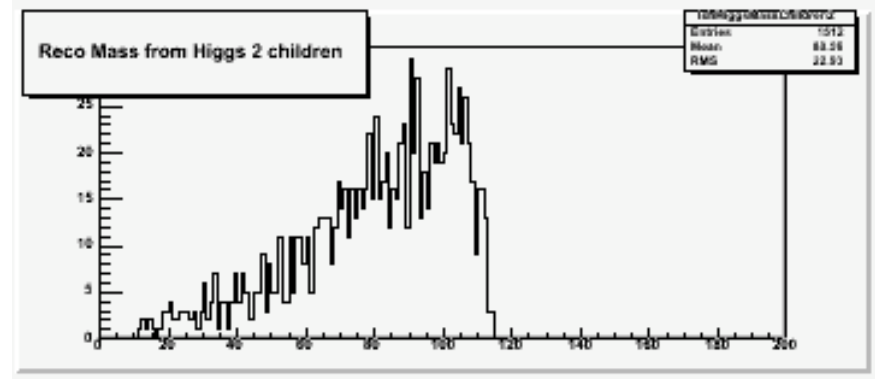
bbar Mass

Select a Higgs and check for its children to select a bbar pair:

- ===Event number 5424 Higgs has 13 children with ID and status of the children
- ID = 5 status = 2
- ID = 21 status = 2
- ID = 21 status = 2
- ID = 21 status = 2
- ID = 21 status = 2
- ID = 21 status = 2
- ID = 21 status = 2
- ID = -2 status = 2
- ID = 2 status = 2
- ID = 21 status = 2
- ID = 21 status = 2
- ID = 21 status = 2
- ID = -5 status = 2
- ====Event Number 5424 After Loop on nhep, Number of Higgs in this event is 1

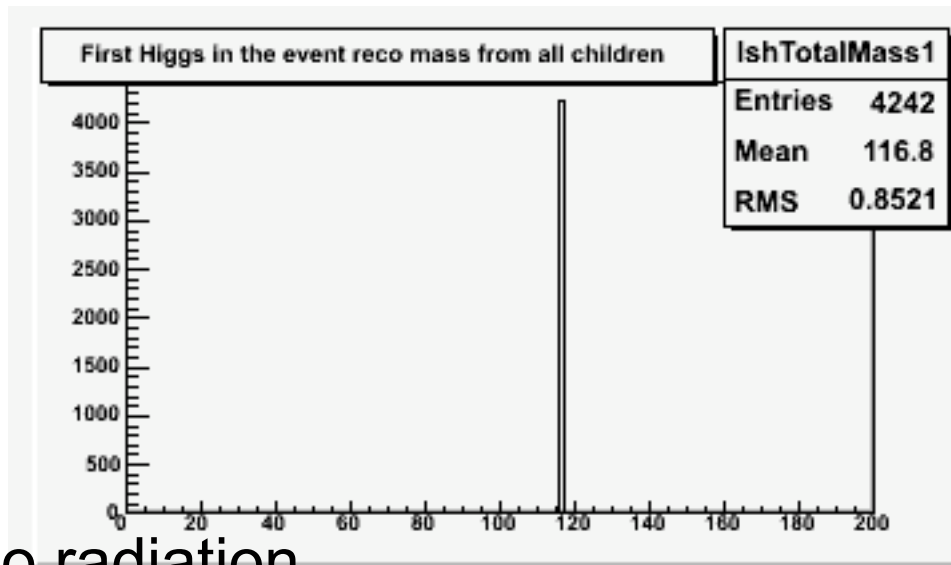


events with 1 Higgs

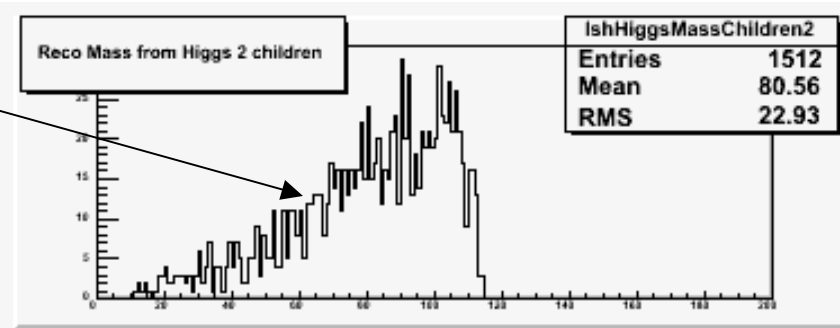
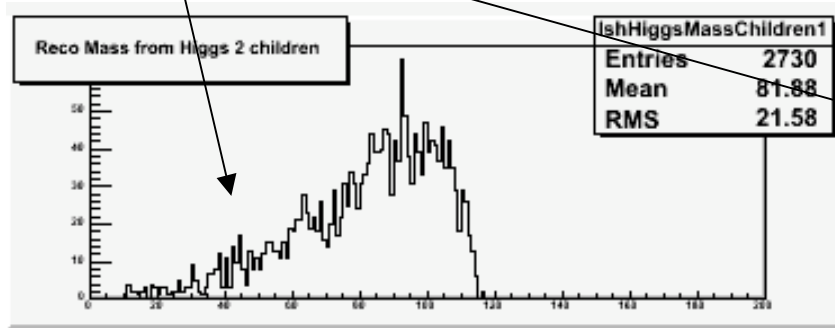


events with 2 Higgses

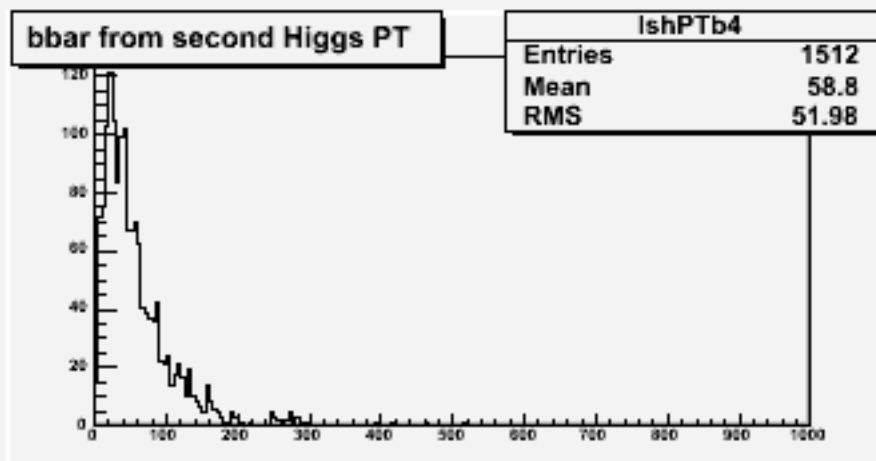
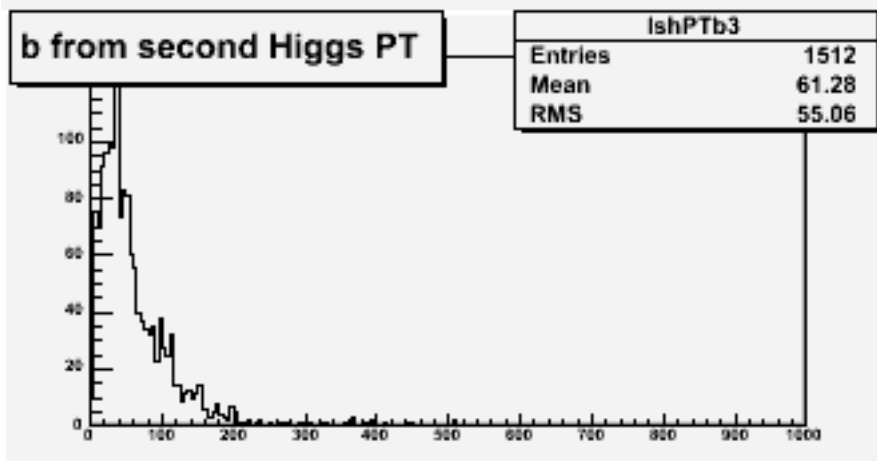
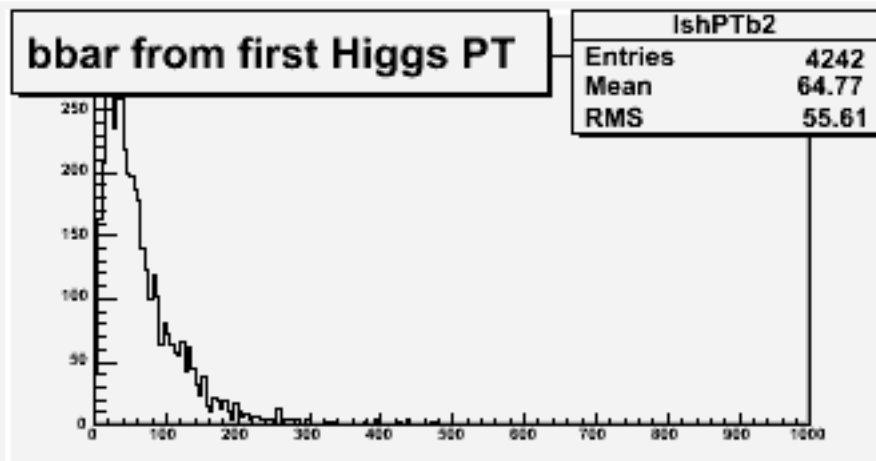
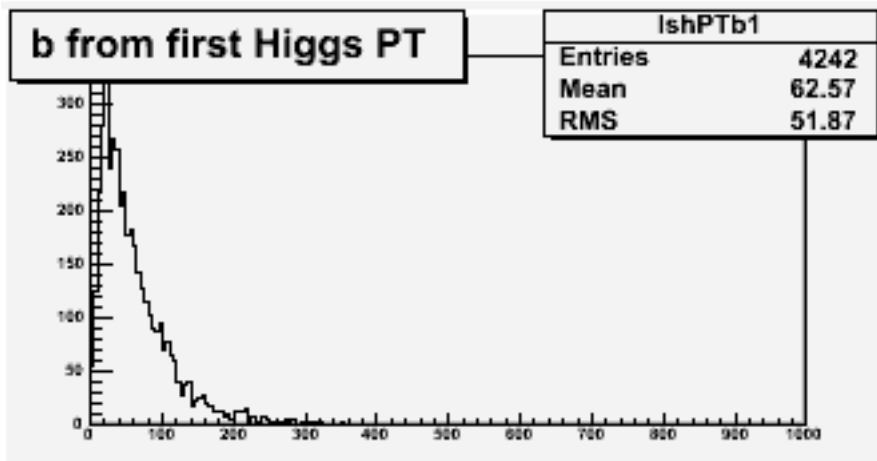
Bbar Mass from ALL children



Low tail due to radiation



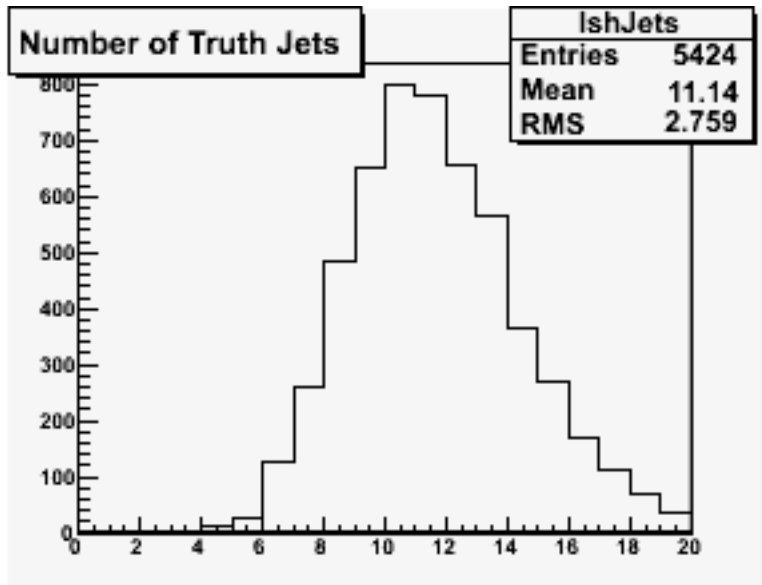
Pt of b partons



Jets

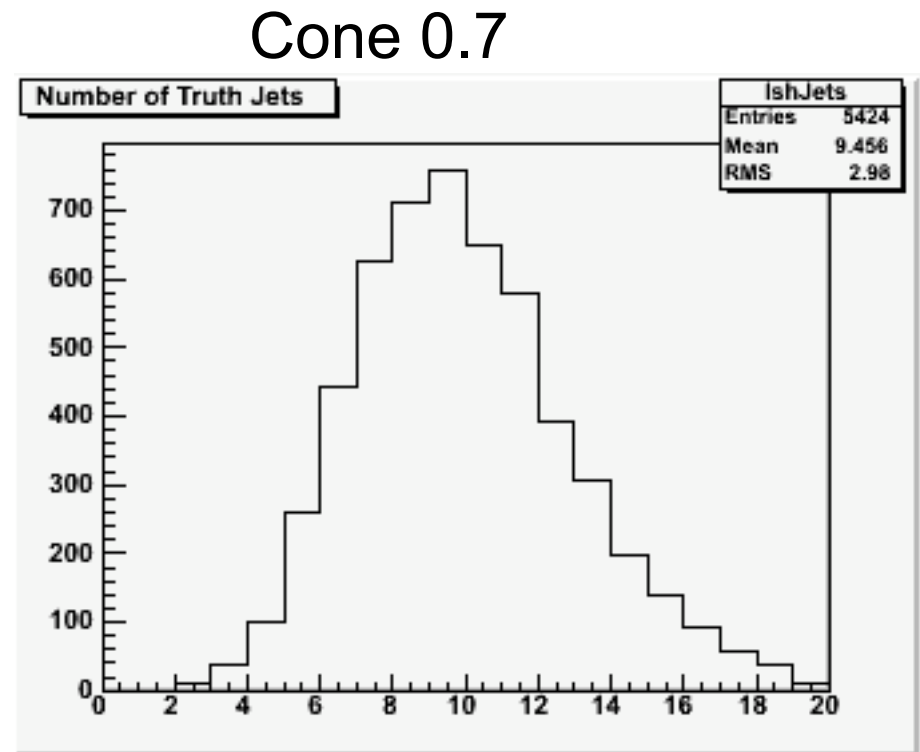
- At generator level we cannot select light jets, there are too many light quarks and gluons coming from the PS.
- I added a TruthJetCollection for jets of cone 0.4 and 0.7

Jet Multiplicities



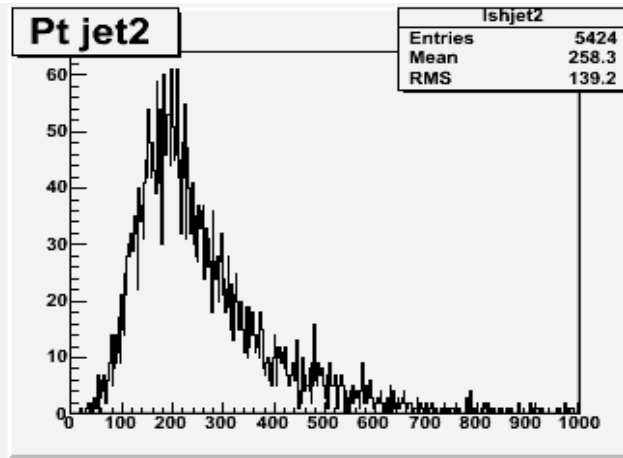
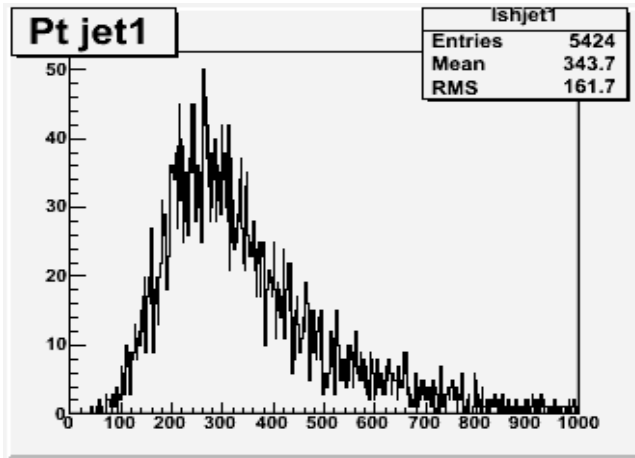
Cone 0.4

Too high!

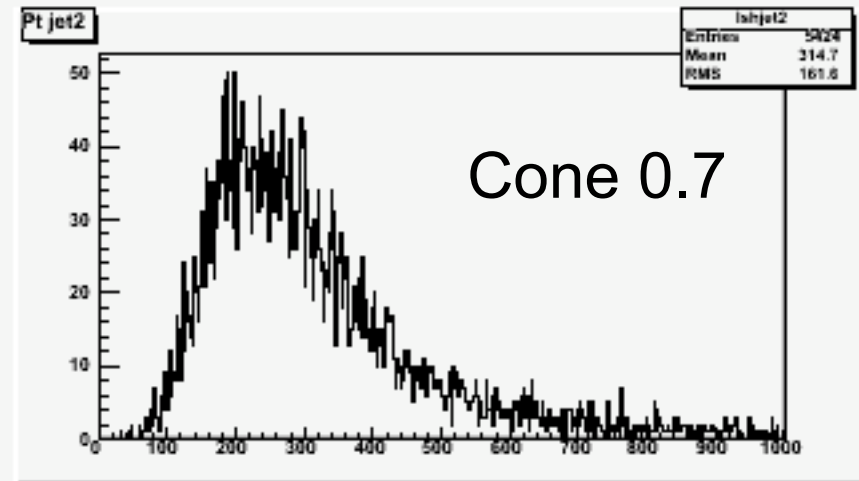
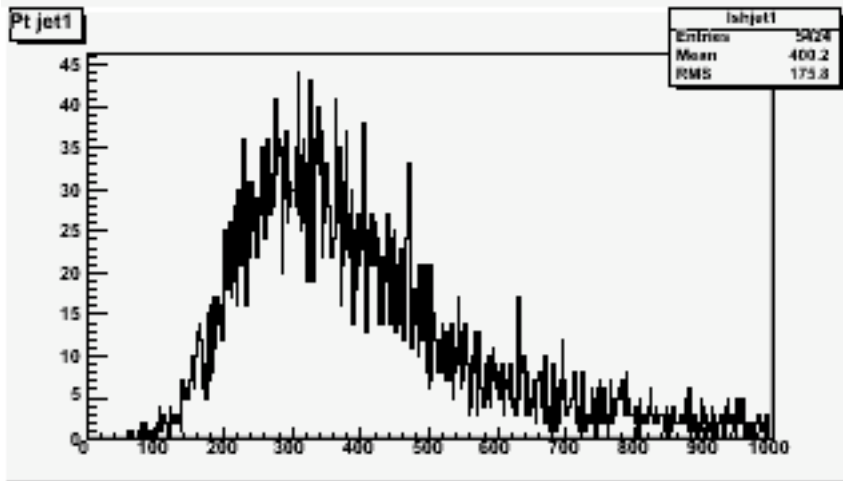


Jets PT

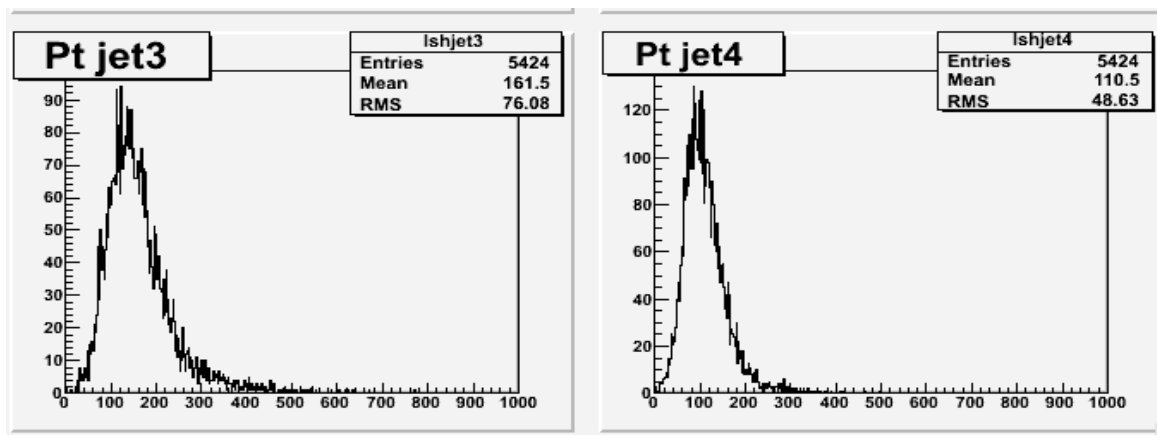
Cone 0.4



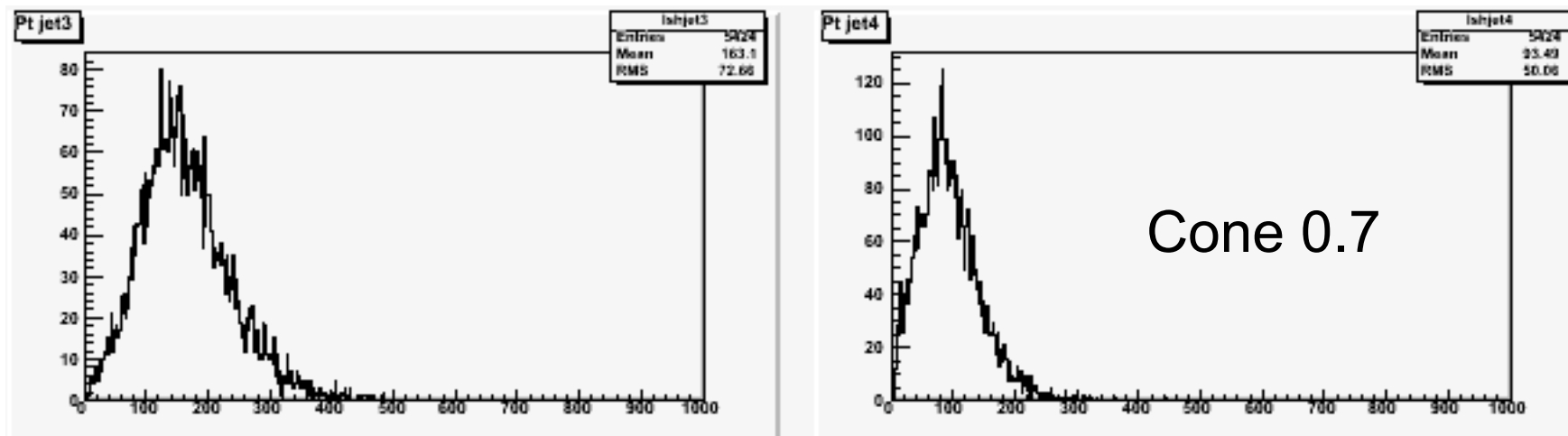
Cone 0.7



Jets PT



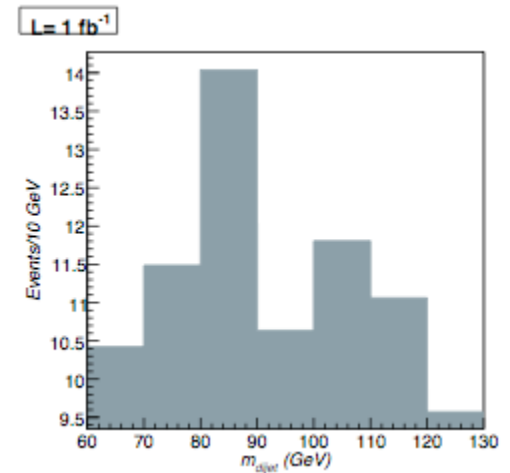
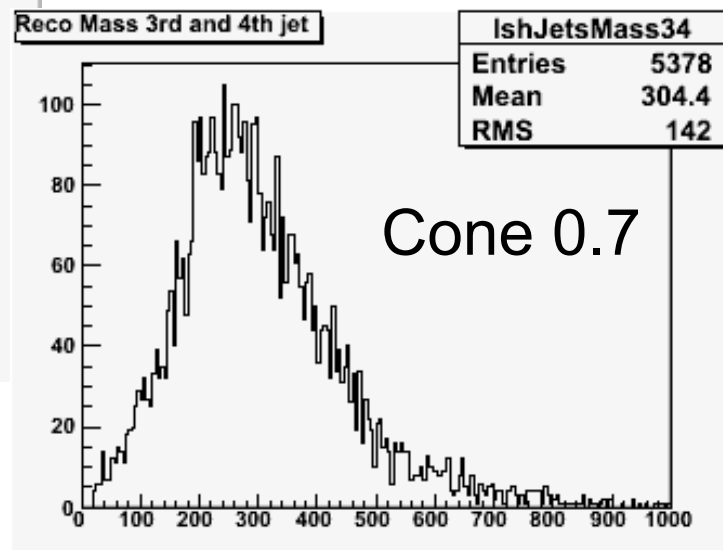
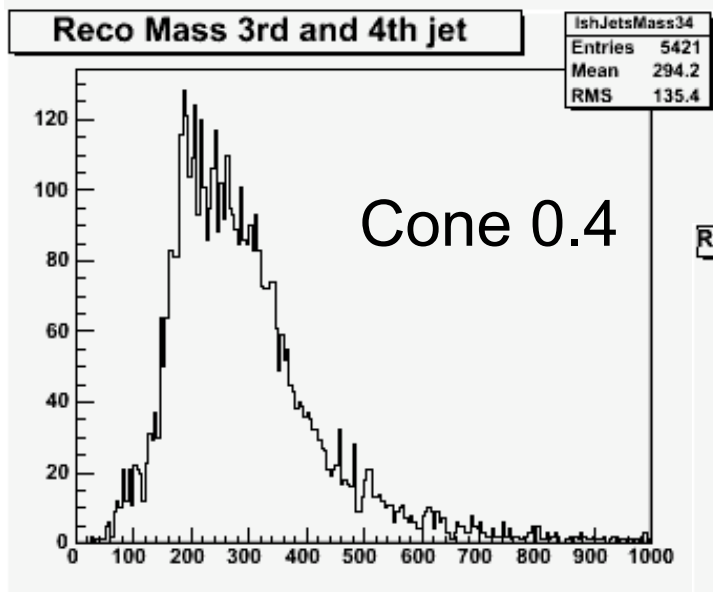
Cone 0.4



Cone 0.7

Mass Combination 3-4

Select events with 1 or 2 sleptons
Pick the 3rd and 4th jet, with $PT > 25$
Combine...



Obviously
something is
wrong...

Mass combination of jets matched to b-bbar pair

Events are selected where is only 1 Higgs (for sake of simplicity)
decaying into bbar

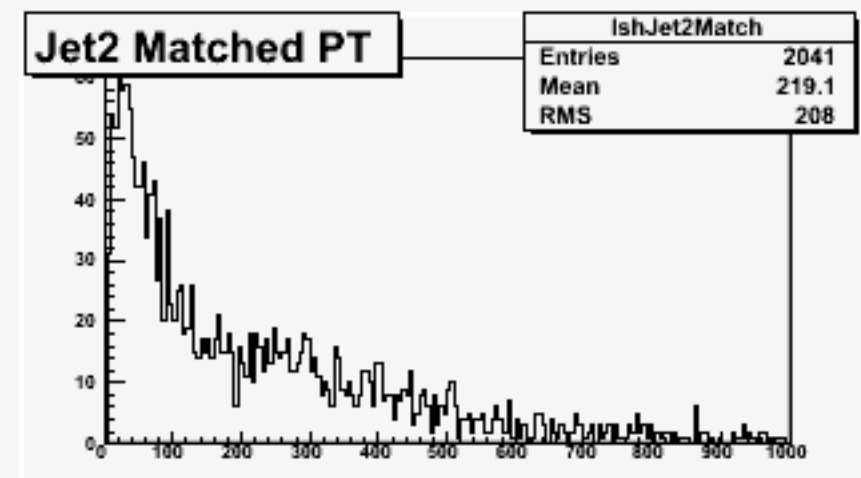
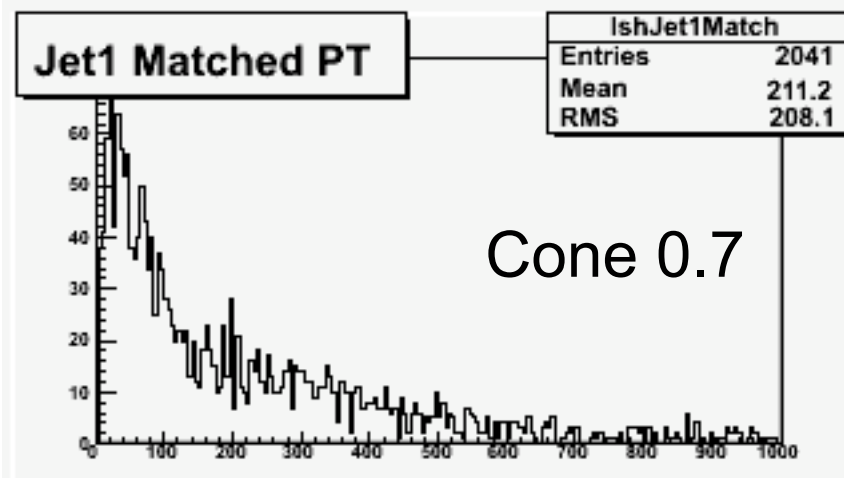
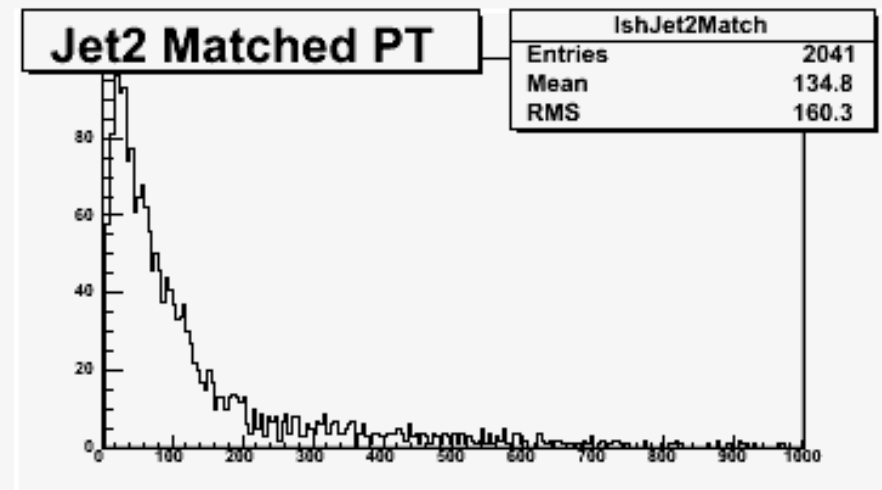
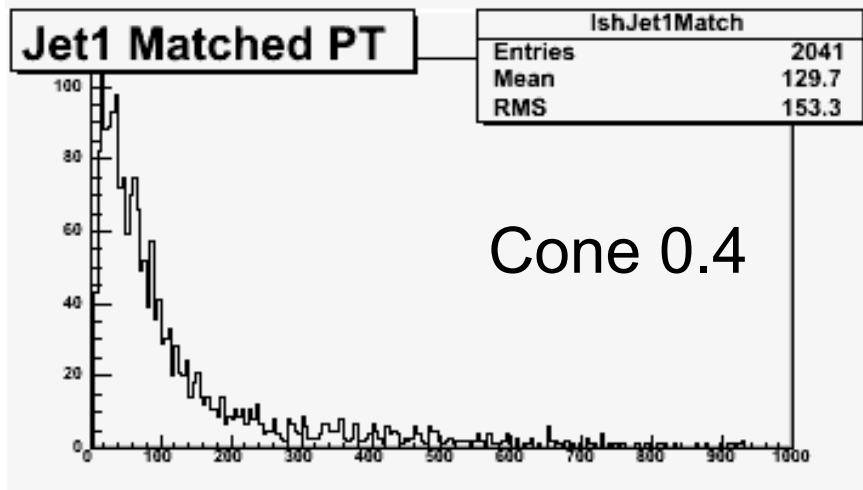
The jets are associated to the bbar via DeltaR:

Example:

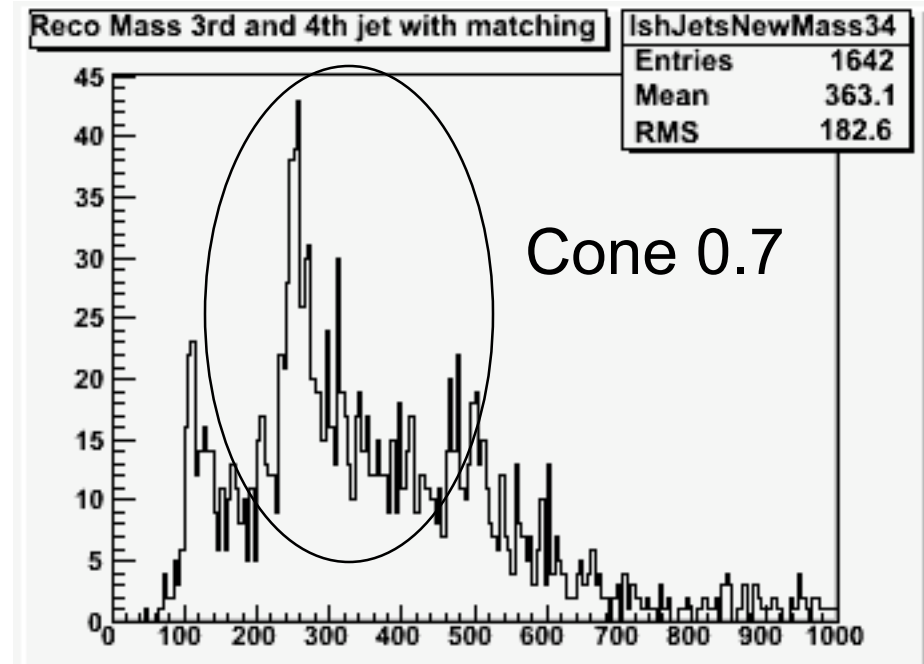
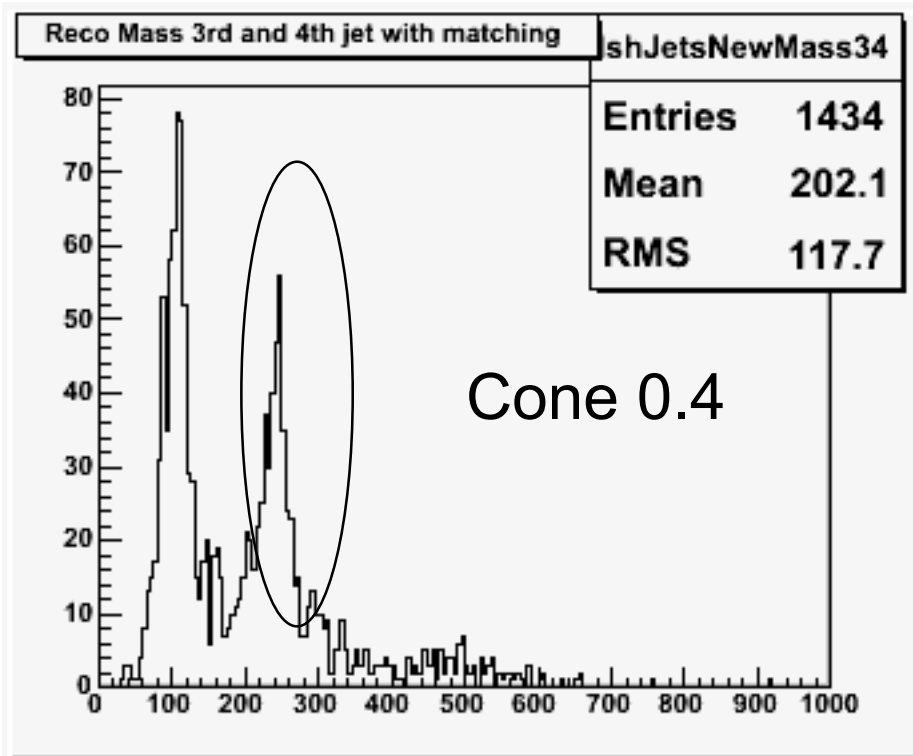
- ===Event Number 5424 Njets = 6 DeltaR with b
- 1.95788, 4.56683, 2.22005, 3.38851, 1.73276, 0.0309958, the minimum is at index 5
- ===Event Number 5424 Njets = 6 DeltaR with bbar
- 0.190557, 4.06416, 2.53475, 3.04445, 2.43456, 1.89726, the minimum is at index 0
- ===Event number 5424 PTB1 = 30.3913 , PTB2 = 401.723
- ===Event 5424 Higgs Mass Reco with Matching is 338.851

This is also a typical example where the reco mass is very high...

Pt of matched jets



Mass combination with matching bbar

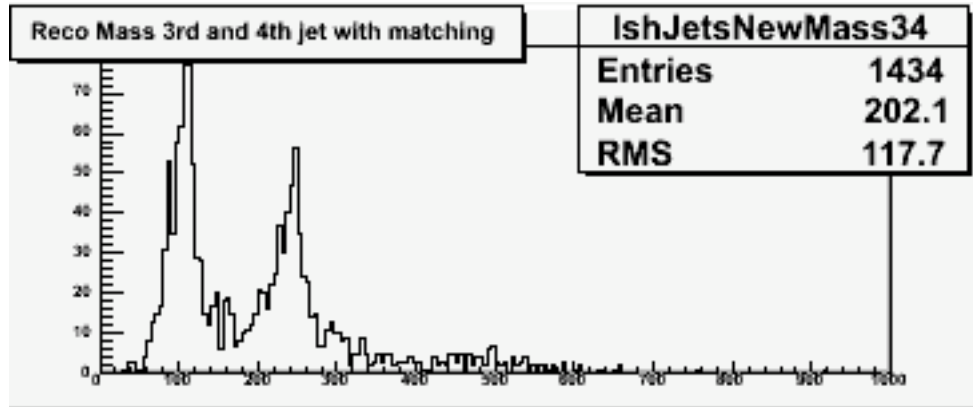


What is the second peak??

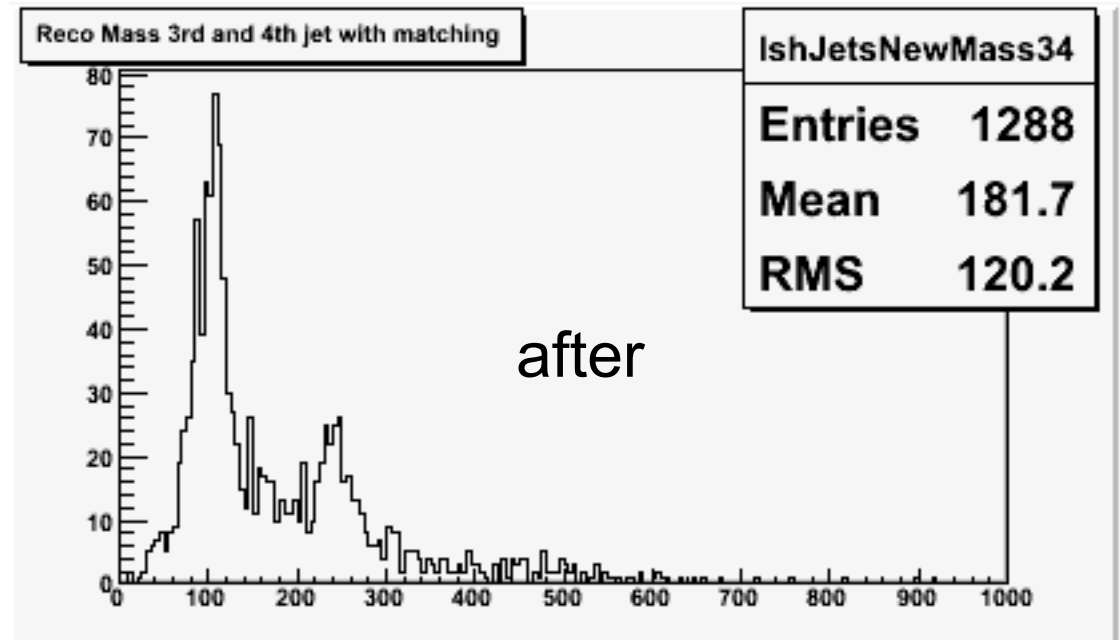
The second peak...

- Hypothesis:
 - The second peak is at the mass of the sleptons...so it could be indeed that TruthJet reconstruction picks the slepton and makes a jet of it...
 - For some reason the “slepton jet” is very close to the b’s from the Higgs and gets picked as the closest jet to the b’s.
 - Solution: remove the 2 jets closest to the 2 sleptons in the event and do the Higgs mass reconstruction with the remaining jets using the 2 closest to the b’s from the Higgs..

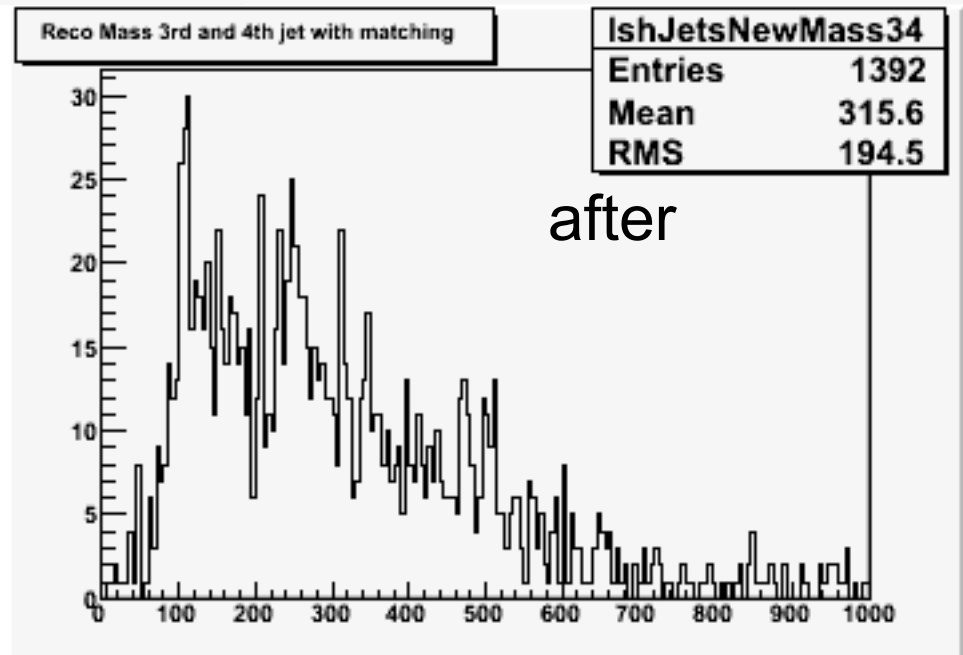
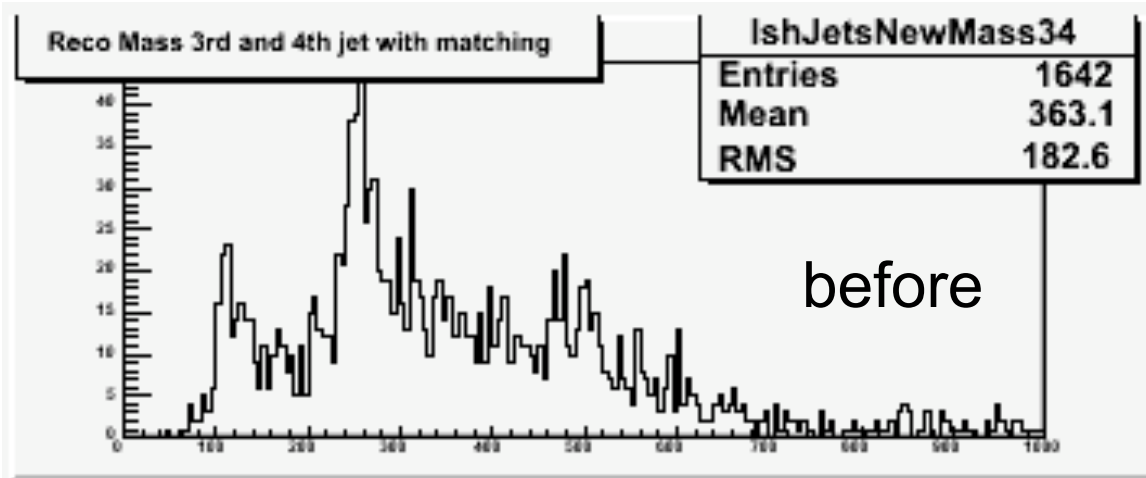
Results 0.4



Before removing the 2
jets closest to
sleptons



Results 0.7



Conclusions

- Pending my next meeting with Ketevi and Veronica we should be now ready to submit a request for production of these samples;
- I consider them ok from the point of view of generator level info
- The TruthJet multiplicity probably reflects mistag of sleptons as jets, so a real reconstruction is now really needed.